Sept. 2, 1941. W. ROTH 2,254,913

ELECTRIC FURNACE

Filed Jan. 18, 1939 2 Sheets-Sheet 1

Fig. 1.

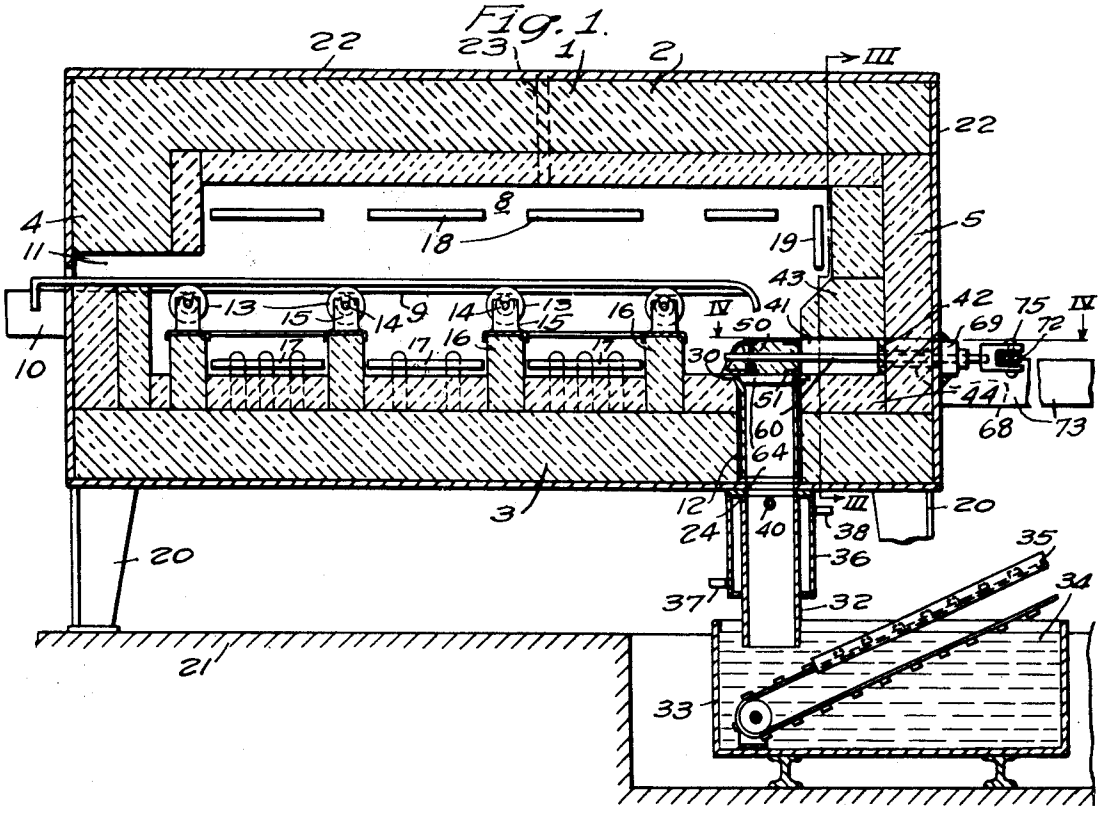


Fig. 2.

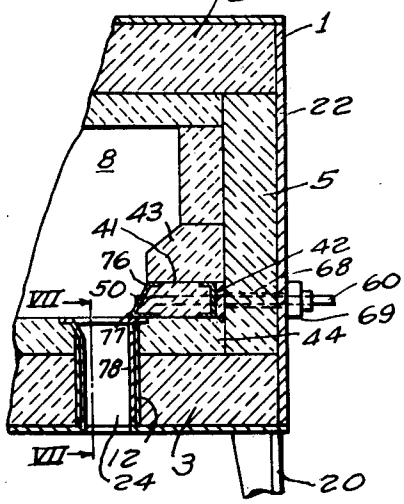
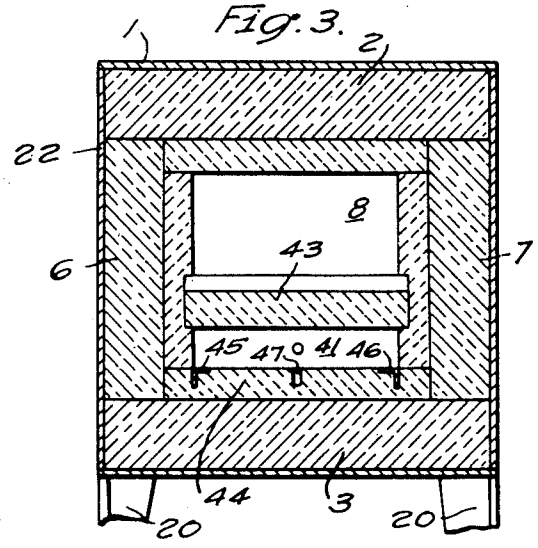


Fig. 3.



WITNESSES:

E. A. McCloskey.

B. L. Fauquier

INVENTOR

Willard Roth.

BY O. B. Buchanan

ATTORNEY

Sept. 2, 1941. W. ROTH 2,254,913

ELECTRIC FURNACE

Filed Jan. 18, 1939 2 Sheets-Sheet 2

Fig. 4.

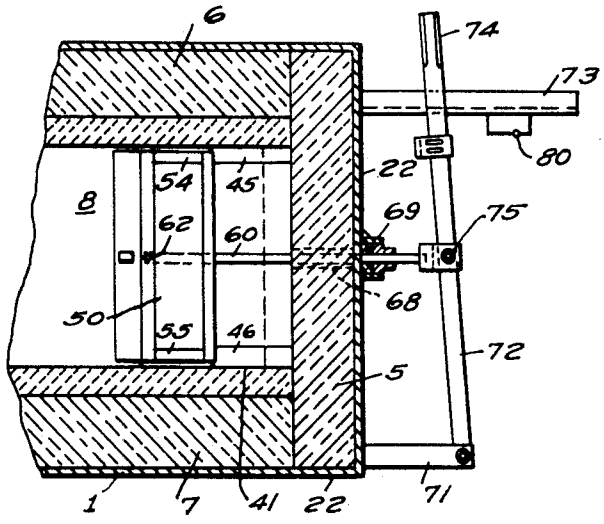


Fig. 5.

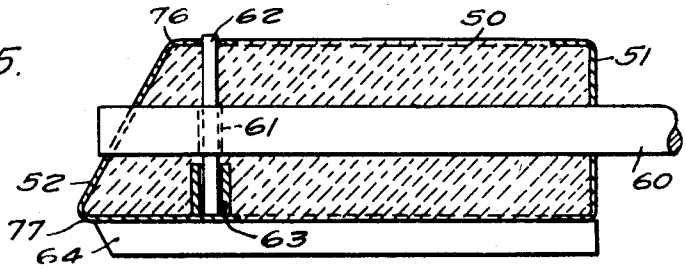


Fig. 8.

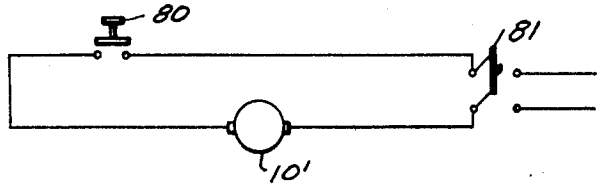


Fig. 6.

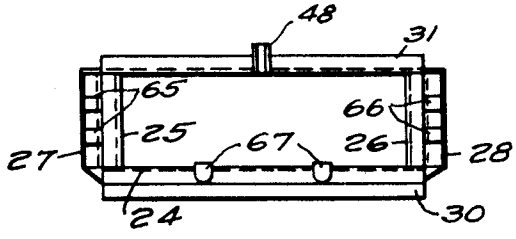
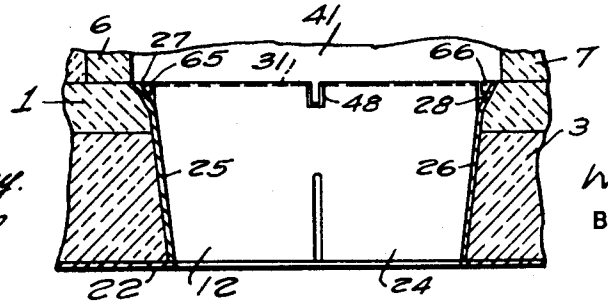


Fig. 7.



WITNESSES:

E. A. McCloskey.

B. L. Zanquill

INVENTOR

Willard Roth.

BY O. B. Buchanan

ATTORNEY

Patented Sept. 2, 1941

2,254,913

UNITED STATES PATENT OFFICE

2,254,913

ELECTRIC FURNACE

Willard Roth, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application January 18, 1939, Serial No. 251,493

8 Claims. (Cl. 266—4)

This invention relates to heat-treating furnaces of the type having a quench-opening, or the equivalent, through a wall thereof, and which is operated periodically, as, for instance, a furnace operated as such during the normal working day of eight hours, and which is then shut down until the next working day. Furnaces of this character are very commonly utilized in the heat-treatment of small articles, such as, for example, nuts, bolts, miscellaneous hardware, certain kinds of tools, and other small parts, or even larger articles. My invention, although not limited thereto, is particularly applicable to that type of furnace which, while in operation, is continually supplied or fed through an entrance opening at the front of the furnace with the articles to be heat-treated, and which is continually discharging the articles after their heat-treatment through a quench-opening at the rear of the furnace, the charge falling into a quench-tank therebelow containing an appropriate quenching liquid.

It is, of course, obvious that such a furnace, during its operation, must be kept at a temperature suitable for the particular heat-treating process involved; that during the shutdown period, which might be for the night, the week-end or any other relatively extended period of time, the furnace will necessarily cool because of the heat losses; and that when the furnace is to be again operated, it must be raised to the desired operating temperature.

Because of the heat losses through the quench-opening during the shutdown period, it has been customary to control the temperature in such furnaces by dividing the heat chamber thereof into at least two zones, each provided with a temperature responsive device for controlling the supply of energy to the heating units in its zone. My invention proposes to eliminate one of the zone controls, and to reduce the losses through the quench-opening, thereby not only lowering the initial cost of the furnace, but also lowering its operating cost.

Broadly, I achieve the object of my invention by providing a closure for the quench-opening which may be operated to quench-closing position for the intervals during which no articles pass through the quench-opening.

The direct advantages of my invention can, perhaps, be illustrated in connection with the operating cycle of an electric furnace actually employed for heat-treating knife blades and to which my invention may be applied. I desire it to be distinctly understood, however, that the values cited in the following illustration are approximate only, and that the illustration is not to be deemed a limitation upon my invention which is obviously applicable to other types of furnaces.

Structurally, the illustrative furnace is well insulated and has a charge entrance through which the blades are fed and distributed onto a charge-conveying means in the heating chamber of the furnace. The charge-conveying means in this particular instance comprises a shaker hearth and operating mechanism which intermittently advances the blades through the chamber. At the end of their journey, the blades fall off the hearth and through an opening in the form of a quench-duct and quench-chute. A quench-tank containing the quenching fluid is disposed below the discharge end of the chute to receive the falling blades.

It is customary in the operation of a quench-type furnace to heat the metal parts as rapidly as possible after their insertion into the furnace, and to this end the furnace being described has its electrical heating elements so placed as to concentrate in the first half of the heating chamber the energy for raising the temperature of the blades. It is not to be inferred, however, that the rest of the furnace is neglected since the chamber throughout substantially the entire heating zone must be kept at the requisite heat-treating temperature, and this requires that energy must be supplied to compensate for the heat losses wherever they occur.

Before the adaptation of my invention to the illustrative furnace, its power consumption per hour was 24.6 kilowatt-hours, of which 17 were required for heat-treating the blades (75% of the last value being concentrated in the first half of the chamber), and 7.6 for supplying the losses. Of the energy lost 4.5 kilowatts were through the entrance chamber and thermal insulation, and 3.1 kilowatts were dissipated through the quench-opening, largely by radiation. It may thus be seen that the quench-opening, even though of relatively small size compared to the heating chamber, allowed a disproportionate amount of the heat in the chamber to escape. However, the heating elements were so designed that during the operation of the furnace under loaded condition a fairly uniform temperature distribution obtained thru the length of the furnace. This required a high concentration of energy in the front half of the furnace. But during the shutdown period of the furnace, the temperature dropped from the operating value of 1500° F. to

900° F. with the coolest section manifestly being about the quench-opening. Accordingly, in order to obtain a quicker and more uniform reheating of the furnace prior to its next operating period, it was necessary to supply a much greater proportion of the heating energy at the rear of the furnace about the quench-opening, not only to raise the temperature of the cooler surrounding parts, but also to supply the high losses thru the open quench-opening.

Thus, it is apparent that the distribution of the heating energy under loaded condition was different from that for reheating or heating up of the empty furnace. Usually, and so far as I am aware, the only practical method heretofore employed for meeting these two requirements was to divide the furnace into at least two temperature control zones, one at the front and one at the rear of the furnace, and each controlling the energy supplied to the heating elements in their respective zones. I have found that the energy need not be concentrated at the rear of the furnace to the extent previously believed desirable if the losses through the quench-opening during the shutdown period and reheating period could be decreased by a suitable heat-insulating closing means therefor, and I have found that if the losses through the quench-opening during the shutdown and reheating periods were decreased, a single-zone control will give satisfactory temperature control of the heating chamber.

Thus, in the furnace for heat-treating knife blades described previously, a suitable closure for the quench-duct reduced the losses through the quench opening from 3.1 kilowatts to lower than 1 kilowatt, at the operating temperature, and hence proportionately reduced the loss of energy during the shutdown period, and consequently reduced the amount and concentration of energy necessary to heat the rear end of the furnace during the reheating period. This factor has enabled me to decrease considerably the time and energy required for reheating the furnace from its cool state to its operating temperature with attendant savings in the cost of operating the furnace.

In accordance with the preferred form of my invention, the closing means for the quench-opening is in the form of a movable section in one of the walls of the furnace, which can be placed in closing position or drawn back into the hollow in the wall by an operating mechanism operable from outside the furnace. During retracted position, the quench-duct closing means forms a part of the furnace wall, while in closing position it effectively insulates the quench-opening without detracting from the insulating properties of the wall of which it forms a part.

Many of the objects, features and advantages of my invention will be apparent from the following description thereof taken in conjunction with the drawings, in which like numerals represent like parts, and in which:

Figure 1 is a somewhat schematic view in longitudinal section of a furnace embodying my invention and showing the quench-duct closure in quench-closing position;

Fig. 2 is a fragmentary view similar to Fig. 1 showing the quench-duct closing means in retracted position;

Fig. 3 is a sectional view of the furnace of Fig. 1 along the lines III—III thereof;

Fig. 4 is an enlarged sectional view along the lines IV—IV of Fig. 1, showing the operating mechanism for the closing means,

Fig. 5 is an enlarged sectional view centrally of the quench-duct closing member;

Fig. 6 is a plan view of the duct defining the quench-opening;

Fig. 7 is an enlarged sectional view taken along the line VII—VII of Fig. 2, showing more particularly the quench-duct structure; and

Fig. 8 is a schematic wiring diagram showing an electrical control for the charge-conveying mechanism.

Referring more particularly to the drawings, the furnace 1 is comprised of a top wall 2, a bottom wall 3, end side walls 4 and 5, and lateral side walls 6 and 7, the walls being constructed of refractory and insulating material, as is customary in the art. The walls jointly define an inner heating chamber 8 in which is disposed a conveyor 9 of the shaker-hearth type having any suitable operating mechanism, shown diagrammatically at 10, including a motor 10', for moving the shaker hearth in such manner that any charges deposited on the hearth through an entrance opening 11 in the front end side wall 4 will be intermittently conveyed to the rear of the furnace and over a quench-opening 12 at the rear of the furnace in the bottom wall 3.

The conveyor hearth 9 may be supported in the heating chamber 8 in any suitable manner, as, for example, upon rollers 13 on shafts 14 journaled in bearing plates 15 that rest upon refractory piers 16, in turn supported on the bottom wall 3. Suitable heating elements 17 are appropriately supported at the bottom of the furnace between the refractory piers 16, and additional heating elements 18 and 19 are suitably supported in the upper part and rear, respectively, of the heating chamber 8 by any well known conventional means. The heating elements in my preferred embodiment are electrical, but it is obvious that other appropriate heating elements may be employed, and heating elements applied to the sides of the furnace if such is deemed necessary.

The furnace is provided at its lower corners with feet 20 which rest upon a suitable foundation 21 for supporting the furnace in its entirety. The furnace is encased in an outer metallic casing 22 to render it impervious to gas, and the top wall 2 is provided with a hole 23 for gas-tightly receiving a thermocouple or other heat-responsive device. This thermocouple is part of a control means for controlling the supply of energy to the various heating elements of the furnace, and, as indicated heretofore, it is sufficient in a furnace embodying my invention to employ but a single temperature-responsive device and energy control means.

The quench-opening 12 in the bottom wall is bounded by a quench-duct 24, shown more particularly in Figs. 6 and 7, which is preferably made from a heat-resistant alloy since it is exposed to the heat of the heating chamber and the charges. The quench-opening extends in one direction substantially across the entire width of the heating chamber, and in the other direction for a fraction of the length thereof, so that relatively the horizontal area of the duct is small compared to the area of a horizontal section of the heating chamber 8. The quench-duct 24 has sides 25 and 26 that are somewhat tapered, with upper edges 27 and 28 of the sides 25 and 26, respectively, being more acutely tapered, so that

the entire duct securely rests upon the walls defining a correspondingly formed aperture in the bottom wall 3. To further aid the retention of the duct in its position, its upper lengthwise ends are formed with flanges 30 and 31 which fit into corresponding grooves in the bottom wall.

Secured to the metallic casing 22 just below the duct 24 and aligned therewith, is a quench-chute 32, which extends into a quench-tank 33 filled with a suitable quench-liquid 34. Any charge which drops from the conveyor 9 will, therefore, fall through the quench-opening into the quench-tank 33 to be properly quenched by the quench-liquid 34. An endless-belt conveyor 35 conveys the charge from the quench-tank to suitable receiving means.

In order to cool the quench-chute so that an inexpensive metal may be employed in its construction, the chute is provided with a water-jacket 36 having a water inlet pipe 37 and a water outlet pipe 38, all as is common in the art.

In the event that the furnace is to be operated with a protective gaseous atmosphere completely enveloping the material being heat-treated, suitable gas inlets may be provided to convey the protective atmosphere to the heating chamber, and suitable exhausts 40 at the bottom of the quench-duct, or thereabouts, may be provided thru which fumes, or the like, resulting from the quench are drawn off by suction, and thus prevented from rising into the heating chamber.

The foregoing structure of the furnace generally follows conventional form, except for the single thermostat opening 23 and the structure of the rear-end side wall 5 which is deliberately modified in accordance with my invention. This wall 5 is preferably formed with a layer of heat insulation material adjacent the outer shell 22 and a layer of refractory tile facing the heating chamber 8. It may be observed that this refractory tile is assembled or formed to provide an elongated hollow portion 41 in the side walls whose bottom is substantially on a level with the flanges of the quench-duct 24. This hollow is of a dimension longitudinally of the furnace slightly greater than the width of the quench-opening.

A thin refractory tile portion 42 is provided at the back end of the hollow 41, and a refractory tile brick 43 defines the upper surface of the hollow 41. The tile brick 43 is preferably shaped so that it has no horizontal or substantially horizontal ledges upon which articles coming off the conveyor 9 may lodge. Thus, as shown, the face of the tile toward the heating chamber is formed of a vertical portion and a rather steep slanting portion so that articles falling on or contacting their surfaces will of their own weight be propelled toward quench-opening 12. The refractory tile 43 may be supported in any suitable manner, and I have shown this tile as comprising a single brick element projecting into the side walls 6 and 7 to an extent sufficient to enable the necessary support therefor to be provided.

The bottom of the hollow 41 is defined by refractory tile 44, and it is immaterial whether this tile be deemed part of the bottom wall 3 or part of the rear-end side wall 5, but for purposes of identification, I prefer to consider the tile 44 as part of the rear-end side wall 5. The tile 44 has embedded therein angle skids 45 and 46 disposed with one side of their angles extending into the tile 44 and the other side forming part of the bottom of the hollow 41, as more particularly shown in Fig. 3. It may be observed that these angles are disposed at the ends of the hollow 41 and serve as guides or skid supports for the quench-duct closing means to be hereinafter described, and are, therefore, preferably of heat-resistant alloy. The top of tile 44 is additionally provided with an open, guiding channel 47 which extends the width of the hollow 41, and is disposed preferably midway between the skids 45 and 46.

Referring again to the duct 24, it may be observed from Figs. 6 and 7 that this member is also formed with a channel 48, and this channel aligns with the channel 47 when the duct 27 is in its proper position in the furnace.

In accordance with the main object of my invention, the hollow 41 is, during the operating condition of the furnace, substantially completely occupied by a movable wall section 50 of suitable refractory material with edges bound in any suitable manner by heat-resistant alloy metal in the form of channel and angle members 51 at the rear, 52 at the front, and 54 and 55 at the sides. It may be observed, however, that the front end of the section 50 is slanted upward and to the rear for a purpose to be later described. Extending horizontally through the wall section 50 is an operating member for moving the wall section from the hollow and into the heating chamber so that it may serve as a closing member for the quench-opening 12.

As may be observed more particularly in Fig. 5, this operating member is in the form of a shaft 60 which extends through suitable fitting apertures in the rear binding member 51 and front binding member 52 of the section 50, and has a vertical hole 61 therethru for receiving a pin 62. The pin 62 is maintained in vertical position by a cup 63 about its lower end, the cup being attached to the inside of the bottom flange of the front end binder member 52, and by an aperture in the upper flange thereof through which the pin extends. Accordingly, it is obvious that a push or pull, as the case may be, upon the shaft 60 will move the entire closing member 50 in the corresponding direction. The closing member is further provided with a heat-resistant metallic guide bar 64 which is vertically disposed centrally between the end binder members 54 and 55, and is adapted to slide in the guiding channel formed by the channels 47 and 48.

In the operation of the wall section or closing member 50, movement of the shaft 60 is transmitted to the section which, in going to the quench-duct closing position, slides upon the skids 45 and 46, being guided by the cooperation between the guide bar 64 and channels 47 and 48. In order to support the closing member while it is being moved and also in its quench-duct closing position, each of the lateral sides 27 and 28 of the quench-duct 24 is provided with a plurality of skid lugs 65 and 66, respectively. Referring to Fig. 7, it may be observed that these lugs are disposed at the upper level of the duct with the tops of the lugs in the plane of the moving bottom surface of the closing member. The lugs 65 and 66 are secured to the duct in any suitable manner, or may even be cast integral with the duct itself. If desired, additional lugs 67, similar to lugs 65 and 66, may be provided on the front end of the duct 24 as an additional supporting means for the section 50 in quench-duct closing position.

The closing member 50 is manually operable in the embodiment shown, and to this end the shaft 60 extends through a suitable aperture 68 in the end wall 5 and casing shell 22. A packed

guide bearing 69 is secured to the casing 22 and about the shaft 60 to provide a guide therefor, and also a seal against any leakage of the gaseous atmosphere in the furnace if such be employed. Also secured to the shell 22 transversely of the guide and seal 69, is a projecting bar 71 which pivotally supports an operating lever 72, the other end of which rides on a surface of a channel member 73 secured to the casing 22 on the side of the shaft 60 that is opposite the bar 71. The operating lever 72 has an extremity 74 beyond the channel member 73, and this extremity serves as a handle to be grasped for moving the shaft 60, which is pivotally secured at 75 to the lever 72.

It should be understood that, with respect to the operating mechanisms and the structure of the closing member 50, all connections for transmitting motion are sufficiently loose, or have sufficient clearance to provide for whatever differences in direction of motion occur between the respective parts at their joining portions, and also in the case of the shaft 60, the aperture 68, the pin 62 and the cup 63 and other parts exposed to heat, to provide for expansion and contraction with changes of temperature.

While the furnace is in operation, the handle 74 is disposed to the right with reference to Fig. 4. In this position, the closing member or wall section 50 fits into the hollow 41, as more particularly shown in Fig. 2, and it may be observed that the dimensions of the tile 43 and the member 50 are chosen so that the top edge 76 of the slanting binder member 52 is slightly within the hollow 41, and the bottom edge 77 is substantially aligned with or slightly beyond the side 78 of the duct 24. By this construction a steep wall surface is presented to articles falling from the conveyor 9 to direct them into the quench-duct, and no ledges are presented upon which some of the articles might lodge.

In addition to serving as a lever in the operating mechanism for the member 50, the lever 72 controls the open and closed position of a switch 80 in the energizing circuit of the motor 10'. The switch 80 can be of any suitable type which will close the circuit of the motor 10' when the lever 72, or a part attached thereto, engages the switch, and will open the circuit when the lever is operated to move the member 50 to quench-duct closing position. The lever-operated switch 80 is, accordingly a protective feature which prevents operation of the conveyor 9 while the member 50 is in quench-duct closing position, and which permits operation of the conveyor when the member 50 nests in the hollow 41. A main switch 81 is also provided in the circuit of the motor 10', and it is obvious that with both switches 80 and 81 closed, the shaker hearth will be operated and any articles deposited thereon will ultimately drop through the open quench-chute into the quench-tank.

In accordance with my invention, the member 50 is moved to quench-duct closing position during the shutdown intervals of the furnace so that the heated interior has no opportunity to radiate, or otherwise lose, heat directly through the quench-opening. Moreover, by constructing the member as a section of the end wall 5 in the manner shown, I also preserve the insulating qualities of this wall since during the shutdown period the hollow 41 is substantially completely encased, the end binder member 51 being substantially aligned with a vertical exposed surface of the tile 43, so that the hollow 41 is in effect a dead air space. Of course, sufficient clearance must be provided between the size of the member 50 and the hollow 41 to permit somewhat free sliding movement of the closure on its skids 45 and 46 under all conditions, but this clearance is relatively small compared to the size of the hollow and does not appreciably decrease the insulating character of the dead air space when the member 50 is over the quench-opening.

As has previously been indicated, the provision of a closing member over the quench-duct during the shutdown period of the furnace has, in one practical embodiment, decreased heat losses from 3.1 kilowatts to less than 1 kilowatt. Moreover, a practically uniform cooling of the heating chamber rather than an unequal cooling during the shutdown period results. Additionally, the use of a closure for the quench opening conserves the heat of the heating chamber so that in the reheating the furnace a lesser amount of energy is consumed.

As has also been hereinbefore mentioned, I have found that by the use of a closing member for the quench-duct I am able to employ a single thermal temperature responsive device, since I am not faced with the problem of supplying a greater amount of heat during the furnace heating-up process, it being understood, of course, that the member is still maintained over the quench-opening during this process.

While I have shown my invention in the form which I now believe to be the best mode of application thereof, it is obvious that many changes may be made within the spirit and scope of my invention. The closure does not necessarily have to be part of a rear-end side wall, but may be obviously divided with parts thereof comprising sections of the lateral side walls, as, for example, 6 and 7. Other modifications are obvious, and it is desired, therefore, that the appended claims be given the broadest construction and limited only by the teachings of the prior art.

I claim as my invention:

1. In a furnace of the class described having a top wall, a bottom wall, and side walls defining a heat-treatment chamber, said bottom wall having a downwardly-directed quench-duct extending substantially for the distance between two side walls; the combination of refractory, slidable closing means for said duct, means for sliding said closing means along the top of said duct to and from duct-closing position and maintaining it in either position, and supporting and guiding means for said closing means including supports forming part of said duct.

2. In a furnace of the class described having a top wall, a bottom wall and side walls defining a heat-treatment chamber, said bottom wall having a quench-duct in proximity to a rear-end side wall of said side walls, said rear-end wall having a hollow portion opening into said chamber with its bottom substantially aligned with the top of said duct, a wall section fitting said hollow portion and slidably movable over said duct to close the same, said section and said rear-end wall having cooperating means serving to guide said section in its movement, and additional supporting means for said section while in duct closing position.

3. In a furnace of the class described having a top wall, a bottom wall and side walls defining a heat-treatment chamber, said bottom wall having a quench-duct in proximity to a rear-end side wall of said side walls, said rear-end wall

having a hollow portion opening into said chamber with its bottom substantially aligned with the top of said duct, a wall section fitting said hollow portion and slidably movable over said duct to close the same, said section and said rear-end wall having cooperating means serving to guide said section in its movement, additional supporting means for said section while in duct closing position, and means for sliding said section including an operating member extending through one of said walls.

4. A furnace of the type described adapted to be operated and shut down alternately for extended periods, said furnace having insulating walls defining a heat-treatment chamber, heating means for said chamber, conveyor means in said chamber, said furnace having a front end including an entrance through which a charge may be deposited on said conveyor means, such furnace also having a quench-duct extending downwardly from said heat-treatment chamber, so disposed with relation to said conveyor means that the charge can drop from said conveyor through said duct, heat-insulated movable closure means, forming part of said walls, for the end of said duct at the heat-treatment chamber, and means for moving said closure means between fixed duct-opening and duct-closing positions.

5. In a device of the class described adapted to be operated and shut down alternately for extended periods, comprising a furnace having top, bottom and side walls defining a heat-treatment chamber, said bottom wall having a downwardly-directed quench-duct in proximity to a rear-end side wall of said side walls, movable closure means for the end of said duct at the heat-treatment chamber, the last said rear-end side wall having a lower portion of a thickness greater than an aligned dimension of said duct, and said means comprising a movable section of said lower portion of an extent less than said thickness but sufficient to cover said duct.

6. The structure of claim 5 wherein said closure means includes an operating member external of the furnace for moving said closure means to and from closing position.

7. In a device of the class described, a furnace comprising top, bottom and side walls defining a heating chamber, said bottom wall having a relatively narrow opening therein defining a quench-duct extending downwardly from said chamber, the upper end of said opening being adjacent to a rear-end side wall of said side walls, charge-conveying means in said chamber adapted to discharge the charge above said upper end, said rear-end wall being formed with a hollow portion substantially at said upper end, a movable wall section fitting in said hollow portion, means for moving said section to close said opening, said rear-end wall and section being so formed that, with the section in said hollow portion, their exposed sides are sufficiently vertical to prevent any charge lodging thereon.

8. The combination with a furnace of the class described having insulating walls defining a heat-treatment chamber, a downwardly-directed quench-duct in an opening through one of said walls, of heat-insulated, movable closure means for said duct, and means for moving said closure means into, and maintaining it in, duct-opening or duct-closing position, said closure means resting in a recess in one of said walls defining said chamber where in duct-opening position, and, in duct-closing position, covering said duct, and also cooperating with said walls to substantially enclose said recess to provide a substantially enclosed, insulating air space thereat.

WILLARD ROTH.